

CLAIMS

We Claim:

- 1 1. A semiconductor chip assembly, comprising:
2 a semiconductor chip that includes first and second opposing surfaces, wherein
3 the first surface of the chip includes a conductive pad;
4 a conductive trace that includes a routing line and a pillar, wherein the pillar
5 includes first and second opposing surfaces and tapered sidewalls therebetween, the
6 first surface of the pillar faces away from the routing line, the second surface of the
7 pillar contacts the routing line, and the tapered sidewalls are adjacent to the first and
8 second surfaces of the pillar and slant inwardly towards the first surface of the pillar;
9 a connection joint that electrically connects the routing line and the pad; and
10 an encapsulant that includes first and second opposing surfaces, wherein the
11 first surfaces of the pillar and the encapsulant face in a first direction, the second
12 surfaces of the pillar and the encapsulant face in a second direction opposite the first
13 direction, the chip, the pillar and the encapsulant extend vertically beyond the routing
14 line in the first direction, the pillar is disposed outside a periphery of the chip, the routing
15 line extends laterally from the pillar towards the chip, the chip and the pillar are
16 embedded in the encapsulant, the encapsulant does not cover the first surface of the
17 pillar, and the conductive trace extends through the first surface of the encapsulant.
- 1 2. The assembly of claim 1, wherein the first surface of the chip faces in the
2 first direction and the second surface of the chip faces in the second direction.
- 1 3. The assembly of claim 1, wherein the first surface of the chip faces in the
2 second direction and the second surface of the chip faces in the first direction.
- 1 4. The assembly of claim 1, wherein the routing line extends vertically
2 beyond the chip in the second direction.

- 1 5. The assembly of claim 1, wherein the routing line extends vertically
2 beyond the pillar in the second direction.
- 1 6. The assembly of claim 1, wherein the routing line extends within and
2 outside the periphery of the chip.
- 1 7. The assembly of claim 1, wherein the routing line is disposed outside the
2 periphery of the chip.
- 1 8. The assembly of claim 1, wherein the routing line is an essentially planar
2 metal lead.
- 1 9. The assembly of claim 1, wherein the pillar is copper.
- 1 10. The assembly of claim 1, wherein the pillar has a conical shape.
- 1 11. The assembly of claim 1, wherein the first surface of the pillar extends
2 vertically beyond the chip in the first direction.
- 1 12. The assembly of claim 1, wherein the first surface of the pillar is laterally
2 aligned with the second surface of the chip.
- 1 13. The assembly of claim 1, wherein the first surface of the pillar extends
2 vertically beyond the encapsulant in the first direction.
- 1 14. The assembly of claim 1, wherein the first surface of the pillar is laterally
2 aligned with the first surface of the encapsulant.

1 15. The assembly of claim 1, wherein the first surface of the pillar is laterally
2 aligned with the first surface of the encapsulant and the second surface of the chip.

1 16. The assembly of claim 1, wherein the second surface of the pillar extends
2 vertically beyond the chip in the second direction.

1 17. The assembly of claim 1, wherein the first and second surfaces of the
2 pillar are flat and parallel to one another, the first surface of the pillar has a first surface
3 area, the second surface of the pillar has a second surface area, and the first surface
4 area is at least 20 percent smaller than the second surface area.

1 18. The assembly of claim 1, wherein the encapsulant covers the chip.

1 19. The assembly of claim 1, wherein the encapsulant does not cover the
2 chip, and the second surface of the chip is exposed.

1 20. The assembly of claim 1, wherein the first surface of the encapsulant is
2 laterally aligned with the second surface of the chip, and the second surface of the chip
3 is exposed.

1 21. The assembly of claim 1, wherein the connection joint is an electroplated
2 metal.

1 22. The assembly of claim 1, wherein the connection joint is an electrolessly
2 plated metal.

1 23. The assembly of claim 1, wherein the connection joint is solder.

1 24. The assembly of claim 1, wherein the connection joint is conductive
2 adhesive.

- 1 26. The assembly of claim 1, wherein the connection joint is a wire bond.
- 1 27. The assembly of claim 26, wherein the wire bond extends vertically
2 beyond the chip and the routing line in the first direction.
- 1 28. The assembly of claim 26, wherein the wire bond extends vertically
2 beyond the chip, the routing line and the pillar in the second direction.
- 1 29. The assembly of claim 1, including an insulative base that contacts the
2 routing line, and extends vertically beyond the chip, the routing line and the pillar in the
3 second direction.
- 1 30. The assembly of claim 29, wherein a through-hole extends through the
2 insulative base, and the connection joint extends into the through-hole.
- 1 31. The assembly of claim 1, including an insulative adhesive that
2 mechanically attaches the chip to the routing line and the pillar.
- 1 32. The assembly of claim 31, wherein a through-hole extends through the
2 adhesive, and the connection joint extends into the through-hole.
- 1 33. The assembly of claim 32, wherein the adhesive contacts and is
2 sandwiched between the routing line and the pad.
- 1 34. The assembly of claim 1, including a first terminal that contacts the first
2 surface of the pillar, extends vertically beyond the pillar in the first direction and is
3 spaced from the connection joint.

1 35. The assembly of claim 1, including a second terminal that contacts the
2 routing line, extends vertically beyond the routing line in the second direction and is
3 spaced from the connection joint.

1 36. The assembly of claim 1, including a first terminal that is plated on the first
2 surface of the pillar, extends vertically beyond the pillar in the first direction and is
3 spaced from the connection joint, and a second terminal that is plated on the routing
4 line, extends vertically beyond the routing line in the second direction and is spaced
5 from the connection joint and the first terminal.

1 37. The assembly of claim 36, including a first solder ball on the first terminal
2 and a second solder ball on the second terminal.

1 38. The assembly of claim 1, including a heat sink that is mechanically
2 attached to the chip, electrically isolated from the chip, overlapped by the chip and
3 disposed vertically beyond the chip in the second direction.

1 39. The assembly of claim 1, including a ground plane that is mechanically
2 attached to the routing line, electrically connected to the routing line, overlapped by the
3 routing line and disposed vertically beyond the routing line in the second direction.

1 40. The assembly of claim 1, wherein the assembly is devoid of wire bonds
2 and TAB leads.

1 41. A semiconductor chip assembly, comprising:
2 a semiconductor chip that includes first and second opposing surfaces, wherein
3 the first surface of the chip includes a conductive pad;
4 a conductive trace that includes a routing line and a pillar, wherein the pillar
5 includes first and second opposing surfaces and tapered sidewalls therebetween, the
6 first surface of the pillar faces away from and is spaced from the routing line, the

7 second surface of the pillar contacts and faces towards the routing line, and the tapered
8 sidewalls are adjacent to the first and second surfaces of the pillar and slant inwardly
9 towards the first surface of the pillar;
10 an insulative base that contacts the routing line;
11 a connection joint that contacts and electrically connects the routing line and the
12 pad; and
13 an encapsulant that includes first and second opposing surfaces, wherein the
14 first surfaces of the pillar and the encapsulant face in a first direction, the second
15 surfaces of the pillar and the encapsulant face in a second direction opposite the first
16 direction, the chip, the pillar and the encapsulant extend vertically beyond the routing
17 line and the connection joint in the first direction, the pillar is disposed outside a
18 periphery of the chip and extends across a thickness of the chip between the first and
19 second surfaces of the chip, the routing line extends laterally from the pillar towards the
20 chip, the chip and the pillar are embedded in the encapsulant, the encapsulant does not
21 cover the first surface of the pillar, the insulative base extends vertically beyond the
22 chip, the routing line and the pillar in the second direction, and the conductive trace
23 extends through the first surface of the encapsulant.

1 42. The assembly of claim 41, wherein the first surface of the chip faces in the
2 first direction and the second surface of the chip faces in the second direction.

1 43. The assembly of claim 41, wherein the first surface of the chip faces in the
2 second direction and the second surface of the chip faces in the first direction.

1 44. The assembly of claim 41, wherein the routing line is an essentially planar
2 metal lead that extends vertically beyond the chip and the pillar in the second direction.

1 45. The assembly of claim 41, wherein the first surface of the pillar extends
2 vertically beyond the chip in the first direction.

1 46. The assembly of claim 41, wherein the first surface of the pillar is laterally
2 aligned with the second surface of the chip.

1 47. The assembly of claim 41, wherein the first surface of the pillar extends
2 vertically beyond the encapsulant in the first direction.

1 48. The assembly of claim 41, wherein the first surface of the pillar is laterally
2 aligned with the first surface of the encapsulant.

1 49. The assembly of claim 41, wherein the first surface of the pillar is laterally
2 aligned with the first surface of the encapsulant and the second surface of the chip.

1 50. The assembly of claim 41, wherein the second surface of the pillar
2 extends vertically beyond the chip in the second direction.

1 51. The assembly of claim 41, wherein the first and second surfaces of the
2 pillar are flat and parallel to one another, the first surface of the pillar has a first surface
3 area, the second surface of the pillar has a second surface area, and the first surface
4 area is at least 20 percent smaller than the second surface area.

1 52. The assembly of claim 41, wherein the encapsulant covers the chip.

1 53. The assembly of claim 41, wherein the first surface of the encapsulant is
2 laterally aligned with the second surface of the chip, and the second surface of the chip
3 is exposed.

1 54. The assembly of claim 41, including an insulative adhesive that contacts
2 and is sandwiched between the chip and the insulative base.

1 55. The assembly of claim 54, wherein a through-hole extends through the
2 insulative base and the adhesive, and the connection joint extends into the through-
3 hole.

1 56. The assembly of claim 55, wherein the adhesive contacts and is
2 sandwiched between the routing line and the pad.

1 57. The assembly of claim 41, including a first terminal that is plated on the
2 first surface of the pillar, extends vertically beyond the pillar and the encapsulant in the
3 first direction and is spaced from the connection joint, and a second terminal that is
4 plated on the routing line, extends vertically beyond the routing line and the
5 encapsulant in the second direction and is spaced from the connection joint and the first
6 terminal.

1 58. The assembly of claim 57, including a first solder ball on the first terminal
2 and a second solder ball on the second terminal.

1 59. The assembly of claim 41, including a heat sink that is mechanically
2 attached to the insulative base, electrically isolated from the chip, overlapped by the
3 chip and disposed vertically beyond the insulative base in the second direction.

1 60. The assembly of claim 41, including a ground plane that is mechanically
2 attached to the insulative base, electrically connected to the routing line, overlapped by
3 the routing line and disposed vertically beyond the insulative base in the second
4 direction.

1 61. A semiconductor chip assembly, comprising:
2 a semiconductor chip that includes first and second opposing surfaces, wherein
3 the first surface of the chip includes a conductive pad;

4 a conductive trace that includes a routing line and a pillar, wherein the pillar
5 includes first and second opposing surfaces and tapered sidewalls therebetween, the
6 first surface of the pillar faces away from and is spaced from the routing line, the
7 second surface of the pillar faces towards and contacts the routing line, and the tapered
8 sidewalls are adjacent to the first and second surfaces of the pillar and slant inwardly
9 towards the first surface of the pillar;
10 an insulative base that contacts the routing line;
11 an adhesive that contacts and is sandwiched between the chip and the insulative
12 base;
13 a plated connection joint that contacts and electrically connects the routing line
14 and the pad in a through-hole that extends through the insulative base and the
15 adhesive; and
16 an encapsulant that includes first and second opposing surfaces, wherein the
17 first surfaces of the pillar and the encapsulant and the second surface of the chip face
18 in a first direction, the first surface of the chip and the second surfaces of the pillar and
19 the encapsulant face in a second direction opposite the first direction, the chip, the pillar
20 and the encapsulant extend vertically beyond the routing line and the connection joint in
21 the first direction, the pillar is disposed outside a periphery of the chip, extends vertically
22 at least as far as the chip in the first direction and extends vertically beyond the chip in
23 the second direction, the routing line extends laterally from the pillar towards the chip,
24 extends within and outside a periphery of the chip and extends vertically beyond the
25 chip and the pillar in the second direction, the chip and the pillar are embedded in the
26 encapsulant, the encapsulant contacts the chip, the pillar and the insulative base, is
27 spaced from the connection joint and does not cover the first surface of the pillar, the
28 insulative base extends vertically beyond the chip, the routing line and the pillar in the
29 second direction, and the conductive trace extends through the first surface of the
30 encapsulant.

1 62. The assembly of claim 61, wherein the first surface of the pillar extends
2 vertically beyond the second surface of the chip in the first direction.

1 63. The assembly of claim 61, wherein the first surface of the pillar extends
2 vertically beyond the encapsulant in the first direction.

1 64. The assembly of claim 61, wherein the first surface of the pillar is laterally
2 aligned with the first surface of the encapsulant and extends vertically beyond the
3 second surface of the chip in the first direction.

1 65. The assembly of claim 61, wherein the first surface of the pillar is laterally
2 aligned with the first surface of the encapsulant and the second surface of the chip, and
3 the second surface of the chip is exposed.

1 66. The assembly of claim 61, wherein the first and second surfaces of the
2 pillar are flat and parallel to one another, the first surface of the pillar has a first surface
3 area, the second surface of the pillar has a second surface area, and the first surface
4 area is at least 20 percent smaller than the second surface area.

1 67. The assembly of claim 61, wherein the adhesive contacts and is
2 sandwiched between the routing line and the pad.

1 68. The assembly of claim 61, including a first terminal that is plated on the
2 first surface of the pillar, extends vertically beyond the pillar and the encapsulant in the
3 first direction and is spaced from the connection joint, and a second terminal that is
4 plated on the routing line, extends vertically beyond the routing line and the
5 encapsulant in the second direction and is spaced from the connection joint and the first
6 terminal.

1 69. The assembly of claim 61, including a heat sink that is mechanically
2 attached to the insulative base, electrically isolated from the chip, overlapped by the
3 chip and disposed vertically beyond the insulative base in the second direction.

1 70. The assembly of claim 61, including a ground plane that is mechanically
2 attached to the insulative base, electrically connected to the routing line, overlapped by
3 the routing line and disposed vertically beyond the insulative base in the second
4 direction.

1 71. A semiconductor chip assembly, comprising:
2 a semiconductor chip that includes first and second opposing surfaces, wherein
3 the first surface of the chip includes a conductive pad;
4 a conductive trace that includes a routing line and a pillar, wherein the pillar
5 includes first and second opposing surfaces and tapered sidewalls therebetween, the
6 first surface of the pillar faces away from and is spaced from the routing line, the
7 second surface of the pillar faces towards and contacts the routing line, and the tapered
8 sidewalls are adjacent to the first and second surfaces of the pillar and slant inwardly
9 towards the first surface of the pillar;
10 an insulative base that contacts the routing line;
11 a bumped connection joint that contacts and electrically connects the routing line
12 and the pad; and
13 an encapsulant that includes first and second opposing surfaces, wherein the
14 first surfaces of the pillar and the encapsulant and the second surface of the chip face
15 in a first direction, the first surface of the chip and the second surfaces of the pillar and
16 the encapsulant face in a second direction opposite the first direction, the chip, the pillar
17 and the encapsulant extend vertically beyond the routing line and the connection joint in
18 the first direction, the pillar is disposed outside a periphery of the chip, extends vertically
19 at least as far as the chip in the first direction and extends vertically beyond the chip in
20 the second direction, the routing line extends laterally from the pillar towards the chip,
21 extends within and outside a periphery of the chip and extends vertically beyond the
22 chip and the pillar in the second direction, the chip and the pillar are embedded in the
23 encapsulant, the encapsulant contacts the chip, the pillar and the insulative base and
24 does not cover the first surface of the pillar, the insulative base extends vertically

25 beyond the chip, the routing line and the pillar in the second direction, and the
26 conductive trace extends through the first surface of the encapsulant.

1 72. The assembly of claim 71, wherein the first surface of the pillar extends
2 vertically beyond the second surface of the chip in the first direction.

1 73. The assembly of claim 71, wherein the first surface of the pillar extends
2 vertically beyond the encapsulant in the first direction.

1 74. The assembly of claim 71, wherein the first surface of the pillar is laterally
2 aligned with the first surface of the encapsulant and extends vertically beyond the
3 second surface of the chip in the first direction.

1 75. The assembly of claim 71, wherein the first surface of the pillar is laterally
2 aligned with the first surface of the encapsulant and the second surface of the chip, and
3 the second surface of the chip is exposed.

1 76. The assembly of claim 71, wherein the first and second surfaces of the
2 pillar are flat and parallel to one another, the first surface of the pillar has a first surface
3 area, the second surface of the pillar has a second surface area, and the first surface
4 area is at least 20 percent smaller than the second surface area.

1 77. The assembly of claim 71, wherein the connection joint is a solder bump.

1 78. The assembly of claim 71, including a first terminal that is plated on the
2 first surface of the pillar, extends vertically beyond the pillar and the encapsulant in the
3 first direction and is spaced from the connection joint, and a second terminal that is
4 plated on the routing line, extends vertically beyond the routing line and the
5 encapsulant in the second direction and is spaced from the connection joint and the first
6 terminal.

1 79. The assembly of claim 71, including a heat sink that is mechanically
2 attached to the insulative base, electrically isolated from the chip, overlapped by the
3 chip and disposed vertically beyond the insulative base in the second direction.

1 80. The assembly of claim 71, including a ground plane that is mechanically
2 attached to the insulative base, electrically connected to the routing line, overlapped by
3 the routing line and disposed vertically beyond the insulative base in the second
4 direction.

1 81. A semiconductor chip assembly, comprising:
2 a semiconductor chip that includes first and second opposing surfaces, wherein
3 the first surface of the chip includes a conductive pad;
4 a conductive trace that includes a routing line and a pillar, wherein the pillar
5 includes first and second opposing surfaces and tapered sidewalls therebetween, the
6 first surface of the pillar faces away from and is spaced from the routing line, the
7 second surface of the pillar faces towards and contacts the routing line, and the tapered
8 sidewalls are adjacent to the first and second surfaces of the pillar and slant inwardly
9 towards the first surface of the pillar;
10 an insulative base that contacts the routing line;
11 an adhesive that contacts and is sandwiched between the chip and the insulative
12 base;
13 a wire bond connection joint that electrically connects the routing line and the
14 pad, wherein the connection joint is electrically connected to the routing line in a first
15 through-hole that extends through the insulative base and is spaced from the adhesive,
16 and the connection joint is electrically connected to the pad in a second through-hole
17 that extends through the insulative base and the adhesive and is spaced from the first
18 through-hole; and
19 an encapsulant that includes first and second opposing surfaces, wherein the
20 first surfaces of the pillar and the encapsulant and the second surface of the chip face

21 in a first direction, the first surface of the chip and the second surfaces of the pillar and
22 the encapsulant face in a second direction opposite the first direction, the chip, the pillar
23 and the encapsulant extend vertically beyond the routing line and the connection joint in
24 the first direction, the pillar is disposed outside a periphery of the chip, extends vertically
25 at least as far as the chip in the first direction and extends vertically beyond the chip in
26 the second direction, the routing line extends laterally from the pillar towards the chip
27 and extends vertically beyond the chip and the pillar in the second direction, the chip
28 and the pillar are embedded in the encapsulant, the encapsulant contacts the chip, the
29 pillar and the insulative base, is spaced from the connection joint and does not cover
30 the first surface of the pillar, the insulative base extends vertically beyond the chip, the
31 routing line and the pillar in the second direction, and the conductive trace extends
32 through the first surface of the encapsulant.

1 82. The assembly of claim 81, wherein the first surface of the pillar extends
2 vertically beyond the second surface of the chip in the first direction.

1 83. The assembly of claim 81, wherein the first surface of the pillar extends
2 vertically beyond the encapsulant in the first direction.

1 84. The assembly of claim 81, wherein the first surface of the pillar is laterally
2 aligned with the first surface of the encapsulant and extends vertically beyond the
3 second surface of the chip in the first direction.

1 85. The assembly of claim 81, wherein the first surface of the pillar is laterally
2 aligned with the first surface of the encapsulant and the second surface of the chip, and
3 the second surface of the chip is exposed.

1 86. The assembly of claim 81, wherein the first and second surfaces of the
2 pillar are flat and parallel to one another, the first surface of the pillar has a first surface

3 area, the second surface of the pillar has a second surface area, and the first surface
4 area is at least 20 percent smaller than the second surface area.

1 87. The assembly of claim 81, including a first terminal that is plated on the
2 first surface of the pillar, extends vertically beyond the pillar and the encapsulant in the
3 first direction and is spaced from the connection joint.

1 88. The assembly of claim 81, including a first terminal that is plated on the
2 first surface of the pillar, extends vertically beyond the pillar and the encapsulant in the
3 first direction and is spaced from the connection joint, and a second terminal that is
4 plated on the routing line, extends vertically beyond the routing line and the
5 encapsulant in the second direction, contacts the connection joint and is spaced from
6 the first terminal.

1 89. The assembly of claim 81, including a heat sink that is mechanically
2 attached to the insulative base, electrically isolated from the chip, overlapped by the
3 chip and disposed vertically beyond the insulative base in the second direction.

1 90. The assembly of claim 81, including a ground plane that is mechanically
2 attached to the insulative base, electrically connected to the routing line, overlapped by
3 the routing line and disposed vertically beyond the insulative base in the second
4 direction.

1 91. A semiconductor chip assembly, comprising:
2 a semiconductor chip that includes first and second opposing surfaces, wherein
3 the first surface of the chip includes a conductive pad;
4 a conductive trace that includes a routing line and a pillar, wherein the pillar
5 includes first and second opposing surfaces and tapered sidewalls therebetween, the
6 first surface of the pillar faces away from and is spaced from the routing line, the
7 second surface of the pillar faces towards and contacts the routing line, and the tapered

8 sidewalls are adjacent to the first and second surfaces of the pillar and slant inwardly
9 towards the first surface of the pillar;
10 an insulative base that contacts the routing line;
11 an adhesive that contacts and is sandwiched between the chip and the insulative
12 base;
13 a wire bond connection joint that electrically connects the routing line and the
14 pad; and
15 an encapsulant that includes first and second opposing surfaces, wherein the
16 first surfaces of the chip, the pillar and the encapsulant face in a first direction, the
17 second surfaces of the chip, the pillar and the encapsulant face in a second direction
18 opposite the first direction, the chip, the pillar, the connection joint and the encapsulant
19 extend vertically beyond the routing line in the first direction, the pillar is disposed
20 outside a periphery of the chip and extends vertically beyond the chip in the first and
21 second directions, the routing line extends laterally from the pillar towards the chip and
22 extends vertically beyond the chip and the pillar in the second direction, the chip and
23 the pillar are embedded in the encapsulant, the encapsulant contacts the chip, the
24 pillar, the insulative base and the connection joint and does not cover the first surface of
25 the pillar, the insulative base extends vertically beyond the chip, the routing line and the
26 pillar in the second direction, and the conductive trace extends through the first surface
27 of the encapsulant.

1 92. The assembly of claim 91, wherein the first surface of the pillar extends
2 vertically beyond the connection joint in the first direction.

1 93. The assembly of claim 91, wherein the first surface of the pillar extends
2 vertically beyond the encapsulant in the first direction.

1 94. The assembly of claim 91, wherein the first surface of the pillar is laterally
2 aligned with the first surface of the encapsulant and extends vertically beyond the
3 connection joint in the first direction.

1 95. The assembly of claim 91, wherein the first and second surfaces of the
2 pillar are flat and parallel to one another, the first surface of the pillar has a first surface
3 area, the second surface of the pillar has a second surface area, and the first surface
4 area is at least 20 percent smaller than the second surface area.

1 96. The assembly of claim 91, including a first terminal that is plated on the
2 first surface of the pillar, extends vertically beyond the pillar and the encapsulant in the
3 first direction and is spaced from the connection joint.

1 97. The assembly of claim 91, including a second terminal that is plated on
2 the routing line, extends vertically beyond the routing line and the encapsulant in the
3 second direction and is spaced from the connection joint.

1 98. The assembly of claim 91, including a first terminal that is plated on the
2 first surface of the pillar, extends vertically beyond the pillar and the encapsulant in the
3 first direction and is spaced from the connection joint, and a second terminal that is
4 plated on the routing line, extends vertically beyond the routing line and the
5 encapsulant in the second direction and is spaced from the connection joint and the first
6 terminal.

1 99. The assembly of claim 91, including a heat sink that is mechanically
2 attached to the insulative base, electrically isolated from the chip, overlapped by the
3 chip and disposed vertically beyond the insulative base in the second direction.

1 100. The assembly of claim 91, including a ground plane that is mechanically
2 attached to the insulative base, electrically connected to the routing line, overlapped by
3 the routing line and disposed vertically beyond the insulative base in the second
4 direction.